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ABSTRACT

The implementation of Taiwan's nationwide constructivist-approach elementary mathematics curriculum has been ongoing for 5 years. From the perspective of systems thinking, Taiwan elementary educational system's mindset as a whole is troubled, and is unable to coordinate with the surrounding community in order to better educational standards. The purpose of this paper is to analyze the implementation process of Taiwan's constructivist-approach elementary mathematics curriculum in terms of Reigeluth's guidelines for the system design process. The paper begins with a brief introduction on the new trend in Taiwan's elementary constructivist mathematics curriculum. It then discusses the difficulties associated with implementation, and the problems caused by those persons in the education community who have a distorted perspective on the reform. Finally, it examines these problems utilizing Reigeluth's guidelines for the system design process for more comprehensive and systemic understanding of the situations. (Contains 14 references.) (AEF)

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Systems Design: An Analysis of the Implementation Process of Taiwan's Constructivist-Approach Elementary Mathematics Curriculum

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Abstract

The purpose of this paper is to analyze the implementation process of Taiwan's constructivist-approach elementary mathematics curriculum in terms of Reigeluth's guidelines for the system design process.

Introduction

The implementation of Taiwan's nationwide constructivist-approach elementary mathematics curriculum has been ongoing for five years. Not surprisingly, as time passes, problems related to this implementation process become increasingly evident. This situation is complex because it not only reveals those difficult issues directly related to the epistemology and instructional methods of mathematics, but also, more seriously, those ones associated with the troubles of Taiwan's entire educational system. From the perspective of systems thinking, Taiwan elementary educational system's mindset as a whole is troubled, and is unable to coordinate with the surrounding community in order to better educational standards.

Taiwan's case is worth examination as it serves as an exemplary case of difficulties associated with the redesign of an educational system. The goal of this paper is to analyze the problems linked to the reform and implementation of Taiwan's elementary constructivist mathematics curriculum. This paper will begin with a brief introduction on the new trend in Taiwan's elementary constructivist mathematics curriculum. I will then discuss the difficulties associated with implementation, and the problems caused by those persons in the education community who have a distorted perspective on the reform. Finally, I will examine these problems utilizing Reigeluth's guidelines for the system design process for more comprehensive and systemic understanding of the situations.

An overview of the new trend in Taiwan's elementary mathematics curriculum

Moving away from the objectivist tradition of didactic and authoritative mathematics education, the Republic of China's Ministry of Education mandated a constructivist approach to the province's elementary mathematics curriculum agenda (Ministry of Education, R.O.C., 1993). Taiwan's elementary mathematics curriculum adopts two major views of constructivist approach: the individual cognitive mainly driving from Piaget (1977) and his followers, and social-cultural mainly driving from Vygotsky (1978) and his followers (Taiwan Province Public School In-Service Teacher Training Service, 1995).

> Individual cognitive view "...emphasizes the constructive activity of the individual as he or she tries to make sense of the world. Learning is seen to occur when the learner's expectations are not met, and he or she must resolve the discrepancy between what was expected and what was actually encountered. Thus, the learning is in the individual's constructions as he or she attempts to resolve the conflict, or alternatively put, individuals literally construct themselves and their world by accommodating to experiences...From this perspective, the importance of the teacher and other students is as a source of perturbation or puzzlement as a stimulus for the individual's learning...Hence, within this framework, the focus is on the individual within the group, and cognition occurs in the head of the individual." (Duffy & Cunningham, 1996, p.175)
>
> Social-cultural view "...emphasizes the socially and culturally situated context of cognition...This approach examines the social origins of cognition, for example, the impact of an individual's appropriation of language as a mediating tool to construct meaning. Collective actions become the focus, as in Rogoff's (1994, p. 209) learning communities, where 'learning occurs as people participate in shared endeavors with others, with all playing active but often asymmetrical roles in social-cultural activity.' It is the changes of ways in which one participates in a community which are crucial, not individual constructions of that activity...Learning, then, is a process of acculturation, and thus the study of social and cultural processes and artifacts is central..." (Duffy & Cunningham, 1996, pp.175-176)

Publishers designed their elementary mathematics instructional methods based on these two approaches. These instructional methods were implemented nationwide in 1996, beginning with first-grade students.

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Examining the problems of implementation

Since 1996, obstacles faced by proponents of reform have become increasingly great. These problems have already hindered the reform's effectiveness, and have even distorted the Ministry of Education's original intentions (Chen, 2001; Chen, 2001; Huang, 2001). As a matter of fact, the original intentions of this reform were to provide learners with opportunities to truly understand mathematics, to discuss mathematics and to collaborate in efforts to solve problems, just as the community of mathematicians did (Huang, 1996). Unfortunately, such intentions did not come into fruition, as many teachers rejected the new instructional methods (Chen, 2001; Chen, 2001; Huang, 2001). Opposition was so great that there were even teachers who planned an early retirement in order to avoid change. A significant number of people in the education community (By this term, I mean officers, professors of education, researchers, and teachers not directly involved in this reform) were unaware of this nationwide mandatory reform. Many parents were against it, and most community members, like those in the education community, did not know of it.

The obstacles above are by no means caused only by issues of the constructivist instructional method itself. They are closely linked to the issues of systemic thinking and the system design process. Due to the lack of insight in viewing this reform as one related to a systemic transformation (a systemic design and implementation process), this reform has encountered enormous obstacles. The current reform of Taiwan's elementary curriculum, like many other past educational reforms, has fallen into the rut of using a piecemeal approach in a desperate attempt to improve fragmented and outdated educational reforms. If educators truly wish to succeed in creating a better educational program, they must abandon such an antiquated approach and instead, focus their attention on the systems design approach.

One must understand that the reform of one or two educational paradigms often affects other aspects of the educational system. The reform of Taiwan's elementary mathematics education is no exception. As Reigeluth states:

> For a fundamental change in education to be lasting and effective, it must be a systemic transformation–one in which changes pervade all aspects of the educational system to account for inter-dependencies among parts of the system. If the change is truly pervasive, it will have an impact, not only on learning in the classroom, but throughout the school and administration, as in the community where it occurs. (Reigeluth, 1990, p.)

The systems design approach directs educational systems design toward a sweeping, comprehensive transformation. Unless we use a systemic approach to review the problems and solutions, we will not be able to give appropriate suggestions for solutions.

In the following section I will use Reigeluth, Norris, and Ryan's "Major Guidelines for the Redesign Process" to analyze the design and implementation of Taiwan's elementary constructivist mathematics curriculum. I believe this approach will guide our mindset to view Taiwan's case in a radical yet systemic way, and help us to build a more comprehensive blueprint for restructuring the educational system so that it may support a constructivist mathematics instruction.

Analysis

Table 1: MAJOR GUIDELINES FOR THE REDESIGN PROCESS

(Adopted from Reigeluth, 1991, p. 9)
Guidelines
Initiating the process:
1. Appraise the climate for systemic change.
2. Make sure you have powerful instigation.
3. Build a school and community coalition of restructurers.
4. Build public support for the change.
5. Document the experience from the beginning.
Design the new system:
6. Involve all stakeholder groups in deciding on and carrying out the design process.
7. Get good leadership and outside facilitation.
8. Develop a common mindset for the new paradigm.
9. Design a feasible model for the system.

10. Establish and maintain communication links.
Planning the implementation:
11. Experiment with tryouts and pilots, and make revisions.
12. Designate time and funds to develop and participate in staff development.
13. Designate time and funds to procure learning resources, and equipment and to remodel facilitation.
14. Obtain active resource support from all stakeholders.
Implementing the design:
15. Allow parents to choose to send their children to the new system.
16. Institutionalize the change process with regular formative evaluations by the stakeholders.
17. Maintain communication with stakeholders, non-participants and outsiders interested in systemic restructuring.
18. Allow three years before doing a summative evaluation.

The above chart outlines the eighteen guidelines proposed by Reigeluth, Norris, & Ryan (1991) to direct the four phases of the educational redesign process. In the following section, I will elaborate on the condition for each guideline.

Initiating the Process

Guideline 1: Appraise the climate for systemic change

Most of the critical players in Taiwan's educational reform did not harbor negative feelings toward the existing system before the reform started; subsequently, they were seemingly unaware of the urgency for a reform of the mathematics curriculum. The motivation for change, in large part, can be attributed to suggestions from two groups: a large number of college-level mathematics education professors and researchers, and a handful of elementary school principles and mathematics teachers who were aware of international trends in elementary mathematics education. These persons proposed to Taiwan's Ministry of Education that Taiwan's official elementary mathematics curriculum be revised; the Ministry of Education authorized them to do so and appointed key figures to edit mathematics textbooks and resources.

Judging from the above, it is apparent that the reform was not a grass-roots action lead by the needs of elementary school teachers, administrators, and parents. Thus, many teachers continue to use traditional instructional methods to teach the new mathematics curriculum. There is no climate for change for the mathematics instructional method, and needless to say, there is no fertile ground for a systemic change of the entire educational system that would support the constructivist mathematics curriculum.

Guideline 2: Make sure you have powerful instigation

Usually, elementary school principals enjoy a great deal of power because they have been directly appointed by Taiwan's Ministry of Education, not the school board. Moreover, the Ministry of Education authorizes them to decree school policies and the administration of educational reform. As principals, the above tasks constitute their primary job responsibilities, and are the basis for promotions. Therefore, school principals are the ones who are most vocal in their support of educational reforms. In contrast, staff members, general administrators and teachers tend to be passive because of their fear of change and their unwillingness to accept the additional burdens associated with such change. Consequently, the principals often have a difficult time finding teachers willing to participate in the reform. Principals often try to find highly motivated and respected teachers to serve as instigators of the reform. If the principals are unable to persuade a sufficient number of such educators, they often order young teachers, who tend to be more obedient to the principal than experienced teachers. In Taiwan, community members (parents, business leaders and other influential persons) seldom become involved actively in school activities. The bulk of school funding comes from central and local taxes, not from businessmen's donations.

Guideline 3: Build a school and community coalition of restructurers

As stated above, community members were far removed from school activities; therefore, there were virtually no partnerships between schools and community members in the school reform process.

Guideline 4: Build public support for the change

Reform took place almost completely in professional, educational circles. Community members, even the students' parents, did not know much of the reform. Over the past few years, the media has only sporadically reported these events; such issues tended to appear solely in scholarly periodicals that deal with education. Meanwhile, the constructivist mathematics curriculum quietly developed on school camp uses.

Guideline 5: Document the experience from the beginning

Taiwan's official model of constructivist mathematics curriculum was tested in several schools over a four-year period before it was deemed fit for application nationwide. A great deal of qualitative and quantitative research has documented the different phases of implementation, for example: teachers' changes in pedagogy (Ko, 1996), the process of instruction (Tzeng, 1997), and students' achievements and shifting attitudes toward mathematics (Chung, 1997). The research results came in both print and non-print forms, and were quite useful. Unfortunately, because of limited quantity and circulation, teachers, parents and administrators did not have many opportunities to access them.

Designing the new system

Guideline 6: Involve all stakeholder groups in deciding on and carrying out the design process

As stated above, only a few mathematics professors, researchers, administrators and teachers initiated and developed this new curriculum. The stakeholder groups in the majority of schools were not involved in the design process. Thus, they were neither familiar with nor enthusiastic about the reform; they could not play the role of advocators for the new curriculum.

Guideline 7: Get good leadership and outside facilitation

Owing to the limited number of persons trained in the new curriculum, there were not enough teachers to demonstrate it in the 2,583 elementary schools throughout Taiwan. Normally, teachers who were somewhat familiar with the new methods simply would supervise their colleagues, or teachers from the same school would form collective training sessions, through which they could learn from each other.

Guideline 8: Develop a common mindset for the new paradigm

Unfortunately, most of those involved in the reform viewed it more in terms of curriculum and instructional methods, rather than in terms of a fundamental change of mindset about education. The reformers failed to create a special atmosphere for sharing common values and goals.

Guideline 9: Design a feasible model for the system

Educators published several instructional models on constructivist mathematics. These models were feasible, and came with teacher's manuals, so they were not too difficult to teach from. However, I think the problems are not in these instructional models, but the problems behind the instructional models and those on the periphery. By "behind," I mean the epistemology and assumption of learning. Peripheral problems are training and diffusion issues. These have been or will be discussed in each guideline, so I will not elaborate on them here.

Guideline 10: Establish and maintain communication links

Communication links entail internal communications such as holding regular public meetings and utilizing various media, and external communications such as linking up with other schools and joining networks (Reigeluth et al, 1991). Not surprisingly, these links were scarce within schools and between schools.

Planning the implementation:

Guideline 11: Experiment with tryouts and pilots, and make revisions

Among the publications implementing elementary constructivist mathematics, only the textbooks designed and developed by Taiwan's government agency were used in the four-year pilot program. The rest of the textbooks did not go through this process, therefore, they created a significant amount of confusion among teachers. This situation proves that the testing process is necessary.

Guideline 12: Designating time and funds to develop and participate in staff development

Neither substantial time nor sufficient funding has been provided to facilitate the diffusion of the reform.

Guideline 13: Designate time and funds to procure learning resources, and equipment and to remodel facilities

The lack of time and funds was regarded as the most frustrating situation for teachers. Teachers complained that, even though there were enough constructivist mathematics instruction resources for them to use, there was a lack of quality instructional media to go with each lesson in the new curriculum.

Guideline 14: Obtain active resource support from all stakeholders

This reform was mandatory, so all stakeholders were supposed to contribute as many human and material resources as possible to the implementation efforts. Teachers also had the obligation to contribute to the implementation efforts. However, this was a mandatory and not a grass-roots action; as a result, not all stakeholders and teachers were involved in the implementation. Some stakeholders rejected the training and opted for early retirement.

Implementing the design:

Guideline 15: Allow parents to choose to send their children to the new system

Since this reform was mandatory, all Taiwanese elementary schools, private and public, took the identical approach to instruction. Parents did not have a say in the matter.

Guideline 16: Institutionalize the change process with regular formative evaluations by the stakeholders

Reigeluth mentioned three kinds of strategies for this guideline: evaluate the system continuously, include all stakeholders in a shared governance system, and consider an equitable choice plan and incentive system to encourage continual systemic change. I do not know if these strategies occurred in Taiwan's case; I need more time to investigate these issues. Regardless, the reform often times dies off within a few years due to a lack of these strategies.

Guideline 17: Maintain communication with stakeholders, non-participants and outsiders interested in systemic restructuring

Taiwanese schools often are isolated from the surrounding communities. These institutions lack a comprehensive channel of communication between those inside and outside, participants and non-participants, or even among stakeholders. Schools tend to introvert themselves, and this closed system is not conducive to reform.

Guideline 18: Allow three years before doing a summative evaluation

To my knowledge, there is no plan yet to conduct a nationwide formative or summative evaluation of this reform. Small-scale formative evaluations on students' achievements in mathematics and attitudes toward the new curriculum were carried out (Chung, 1997).

Conclusion

In this paper, I started with the significance of the study of the implementation of Taiwan's constructivist-approach elementary mathematics curriculum. I briefly described its new trends and revealed the problems related to such educational reform by examining the difficulties associated with the implementation of this curriculum. In order to achieve an appropriate perspective to view these problems, it was necessary to utilize a systems design approach rather than a piecemeal approach. Reigeluth's guidelines for the design process were used to analyze the situation. These guidelines guided us to view these situations both comprehensively and systematically through four phases of design process. Therefore we did not miss any essential process to be trapped into a partial perspective, like the blinds touched an elephant. Further, they will continue to guide us on how to take action for future reform action.

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